ULTRA HIGH FREQUENCY OPERATIONAL AMPLIFIER — SE/NE5539

DESCRIPTION

The Signetics SE/NE5539 is a very wide bandwidth, high slew rate, monolithic operational amplifier for use in video amplifiers, RF amplifiers, and extremely high slew rate amplifiers.

Emitter follower inputs provide a true differential high input impedance device. Proper external compensation will allow design operation over a wide range of closed loop gains, both inverting and non-inverting, to meet specific design requirements.

FEATURES

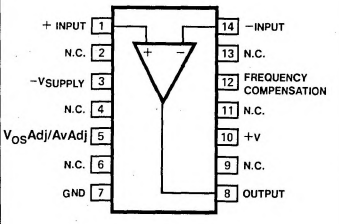
- **Gain bandwidth product: 1.2GHz at 17dB**
- **Slew rate: 600/Vμsec**
- **Full power response: 48MHz**
- **A_{VOL}: 52dB typical**
- **350MHz unity gain**

APPLICATIONS

- **Fast pulse amplifiers**
- **RF oscillators**
- **Fast sample and hold**
- **High gain video amplifiers (BW > 20MHz)**

PIN CONFIGURATION

D,F,N PACKAGE



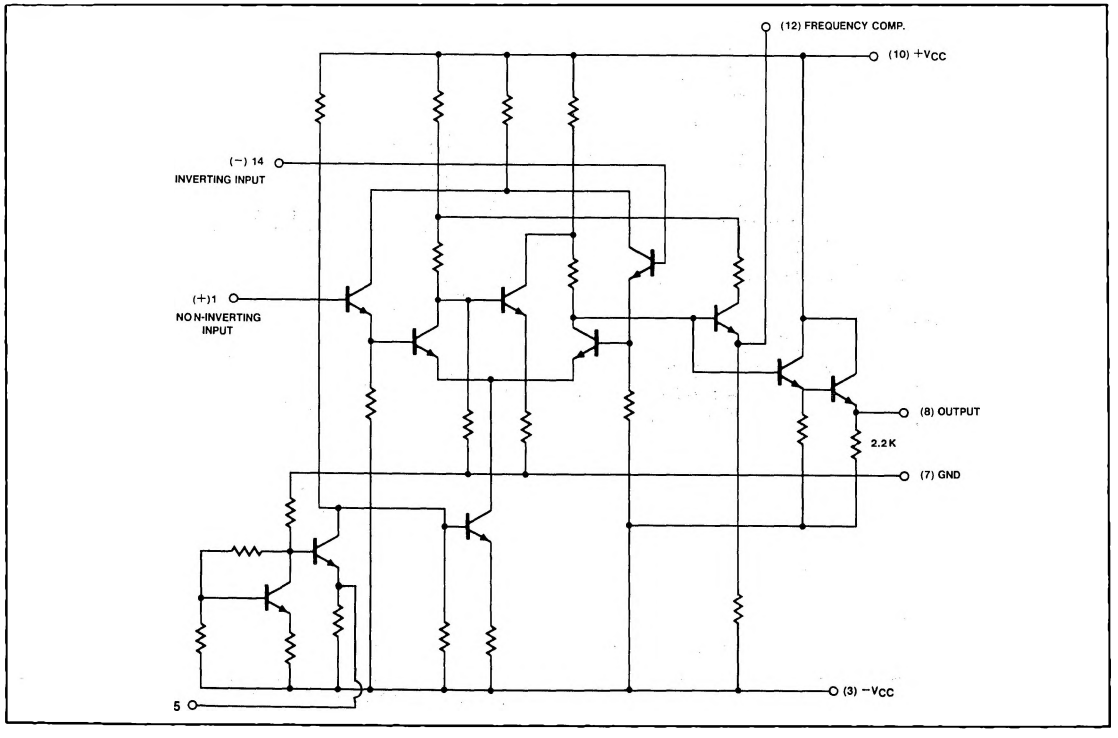
TOP VIEW

ORDER NUMBERS
SE/NE5539F SE/NE5539N
NE5539D

ABSOLUTE MAXIMUM RATINGS

	PARAMETER	RATING	UNIT
V_{CC}	Supply voltage	± 12	V
P_D	Internal power dissipation	550	mW
T_{STG}	Storage temperature range	−65 to +150	°C
T_J	Max junction temperature	150	°C
T_A	Operating temperature range		
	NE	0 to 70	°C
	SE	−55 to +125	°C
	Lead temperature	300	°C

EQUIVALENT CIRCUIT



ULTRA HIGH FREQUENCY OPERATIONAL AMPLIFIER SE/NE5539

DC ELECTRICAL CHARACTERISTICS $V_{CC} = \pm 8V$, $T_A = 25°C$ unless otherwise specified

PARAMETER	TEST CONDITIONS		SE5539			NE5539			UNIT
			Min	Typ	Max	Min	Typ	Max	
V_{OS} Input offset voltage	$V_O = 0V$, $R_S = 100\Omega$	Over temp		2	5				mV
		$T_A = 25°C$		2	3		2.5	5	
$\Delta V_{OS}/\Delta T$				5			5		$\mu V/°C$
I_{OS} Input offset current		Over temp		.1	3				μA
		$T_A = 25°C$		.1	1			2	
$\Delta I_{OS}/\Delta T$				.5			.5		nA/°C
I_B Input bias current		Over temp		6	25				μA
		$T_A = 25°C$		5	13		5	20	
$\Delta I_B/\Delta T$				10			10		nA/°C
CMRR Common mode rejection ratio	$F = 1kHz$, $R_S = 100\Omega$, $V_{CM} \pm 1.7V$		70	80		70	80		dB
		Over temp	70	80					dB
R_{IN} Input impedance				100			100		kΩ
R_{OUT} Output impedance				10			10		Ω
V_{OUT} Output voltage swing	$R_L = 150\Omega$ to GND and 470Ω to $-V_{CC}$	+Swing				+2.3	+2.7		V
		−Swing				−1.7	−2.2		
V_{OUT} Output voltage swing	$R_L = 2k\Omega$ to GND, Over temp	+Swing	+2.3	+3.0					V
		−Swing	−1.5	−2.1					
	$R_L = 2k\Omega$ to GND, $T_A = 25°C$	+Swing	+2.5	+3.1					V
		−Swing	−2.0	−2.7					
$I_{CC}+$ Positive supply current	$V_O = 0$, $R_1 = \infty$	Over temp		14	18				mA
		$T_A = 25°C$		14	17		14	18	
$I_{CC}-$ Negative supply current	$V_O = 0$, $R_1 = \infty$	Over temp		11	15				mA
		$T_A = 25°C$		11	14		11	15	
PSRR Power supply rejection ratio	$\Delta V_{CC} = \pm 1V$	Over temp		300	1000				$\mu V/V$
		$T_A = 25°C$					200	1000	
A_{VOL} Large signal voltage gain	$V_O = +2.3V, -1.7V$, $R_L = 150\Omega$ to GND, 470Ω to $-V_{CC}$					47	52	57	dB
A_{VOL} Large signal voltage gain	$V_O = +2.3V, -1.7V$, $R_L = 2K$ to GND								dB
		$T_A = 25°C$				47	52	57	
A_{VOL} Large signal voltage gain	$V_O = +2.5V, -2.0V$, $R_L = 2k\Omega$ to GND	Over temp	46		60				dB
		$T_A = 25°C$	48	53	58				

NOTE

1. Differential input voltage should not exceed 0.25 volts to prevent excessive input bias current and common mode voltage 2.5 volts. These voltage limits may be exceeded if current limit is 10mA.

ULTRA HIGH FREQUENCY OPERATIONAL AMPLIFIER SE/NE5539

AC ELECTRICAL CHARACTERISTICS $V_{CC} = \pm 8V$, $R_L = 150\Omega$ to GND & 470Ω to $-V_{CC}$ unless otherwise specified.

PARAMETER	TEST CONDITIONS	SE5539			NE5539			UNIT
		Min	Typ	Max	Min	Typ	Max	
Gain bandwidth product	$A_{CL} = 7$ $V_O = 0.1$ Vp-p		1200			1200		MHz
Small signal bandwidth	$A_{CL} = 2$ $R_L = 150\Omega$[1]		110			110		MHz
Settling time	$A_{CL} = 2$ $R_L = 150\Omega$[1]		15			15		nSec
Slew rate	$A_{CL} = 2$ $R_L = 150\Omega$[1]		600			600		V/μSec
Propagation delay	$A_{CL} = 2$ $R_L = 150\Omega$[1]		7			7		nSec
Full power response	$A_{CL} = 2$ $R_L = 150\Omega$[1]		48			48		MHz
Full power response	$A_V = 7$, $R_L = 150\Omega$		20			20		MHz
Input noise voltage	$R_S = 50\Omega$		4			4		nV/$\sqrt{Hz}$

NOTE 1: External compensation.

DC ELECTRICAL CHARACTERISTICS $V_{CC} = \pm 6V$, $T_A = 25°C$ unless otherwise specified

PARAMETERS		TEST CONDITIONS			SE5539			UNIT
					Min	Typ	Max	
V_{OS}	Input offset voltage			Over temp		2	5	mV
				$T_A = 25°C$		2	3	
I_{OS}	Input offset current			Over temp		.1	3	μA
				$T_A = 25°C$		.1	1	
I_B	Input bias current			Over temp		5	20	μA
				$T_A = 25°C$		4	10	
CMRR	Common mode rejection ratio	$V_{CM} = \pm 1.3V$, $R_S = 100\Omega$			70	85		dB
$I_{CC}+$	Positive supply current			Over temp		11	14	mA
				$T_A = 25°C$		11	13	
$I_{CC}-$	Negative supply current			Over temp		8	11	mA
				$T_A = 25°C$		8	10	
PSRR	Power supply rejection ratio	$\Delta V_{CC} = \pm 1V$		Over temp		300	1000	μV/V
				$T_A = 25°C$				
V_{OUT}	Output voltage swing	$R_L = 150\Omega$ to GND and 390Ω to $-V_{CC}$	Over temp	+ Swing	+ 1.4	+ 2.0		V
				− Swing	− 1.1	− 1.7		
			$T_A = 25°C$	+ Swing	+ 1.5	+ 2.0		
				− Swing	− 1.4	− 1.8		

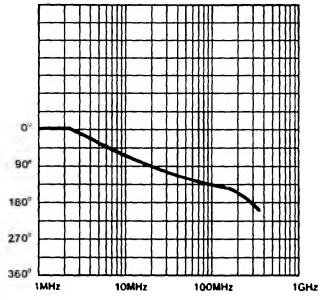
AC ELECTRICAL CHARACTERISTICS $V_{CC} = \pm 6V$, $R_L = 150\Omega$ to GND and 390Ω to $-V_{CC}$ unless otherwise specified

PARAMETER	TEST CONDITIONS	SE5539			UNIT
		Min	Typ	Max	
Gain bandwidth product	$A_{CL} = 7$		700		MHz
Small signal bandwidth	$A_{CL} = 2$[1]		120		MHz
Settling time	$A_{CL} = 2$[1]		23		ns
Slew rate	$A_{CL} = 2$[1]		330		V/μs
Propagation delay	$A_{CL} = 2$[1]		4.5		ns
Full power response	$A_{CL} = 2$[1]		20		MHz

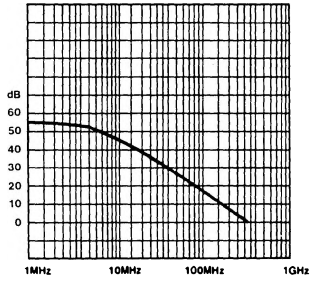
NOTE 1: External compensation.

ULTRA HIGH FREQUENCY OPERATIONAL AMPLIFIER SE/NE5539

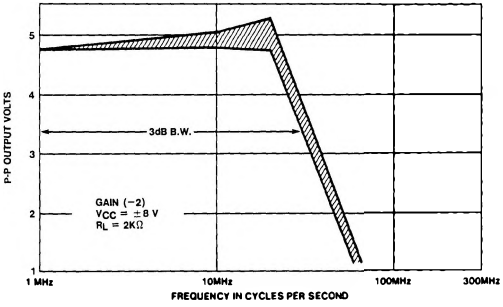
NE5539 OPEN LOOP PHASE



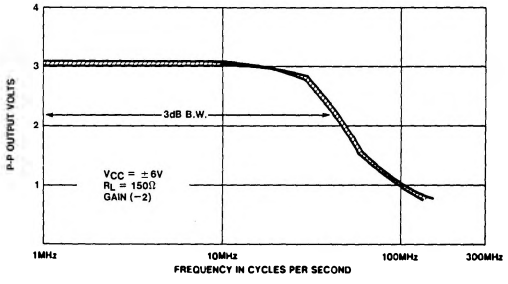
NE5539 OPEN LOOP GAIN



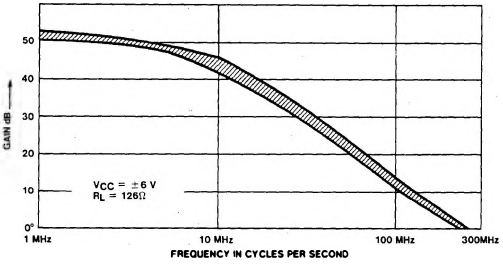
POWER BANDWIDTH (SE)



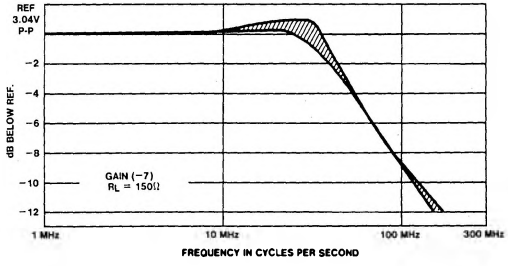
POWER BANDWIDTH (NE)



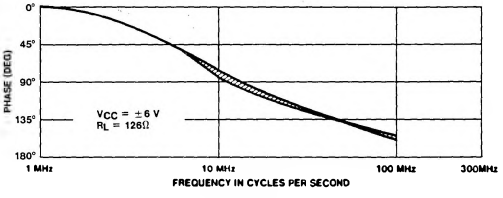
SE5539 OPEN LOOP GAIN vs FREQUENCY



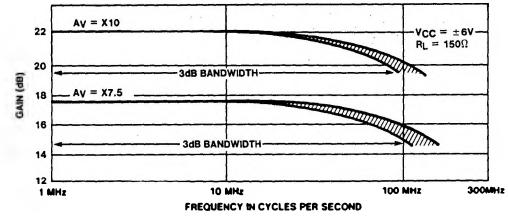
POWER BANDWIDTH



SE5539 OPEN LOOP PHASE vs FREQUENCY



GAIN BANDWIDTH PRODUCT vs FREQUENCY



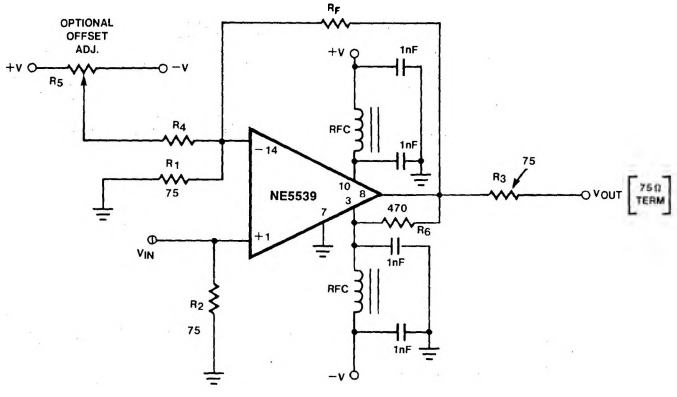
NOTE

Indicates typical distribution $-55°C \leq T_A \leq 125°C$

ULTRA HIGH FREQUENCY OPERATIONAL AMPLIFIER SE/NE5539

CIRCUIT LAYOUT CONSIDERATIONS

As may be expected for an ultra-high frequency, wide gain bandwidth amplifier, the physical circuit layout is extremely critical. Breadboarding is not recommended. A double-sided copper clad printed circuit board will result in more favorable system operation. An example utilizing a 28dB non-inverting amp is shown in Figure 1.

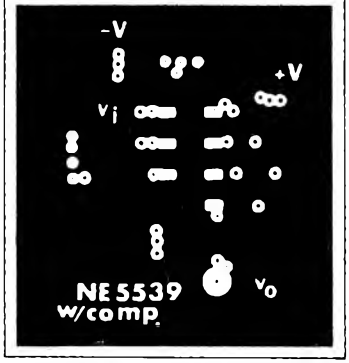


R_1 = 75Ω 5% CARBON
R_2 = 75Ω 5% CARBON
R_3 = 75Ω 5% CARBON
R_4 = 36K 5% CARBON

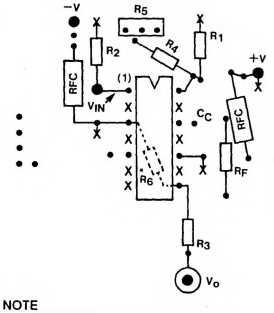
R_5 = 20K TRIMPOT (CERMET)
R_F = 1.5K (28dB GAIN)
R_6 = 470Ω 5% CARBON

RFC 3T # 26 BUSSWIRE ON FERROXCUBE VK 200 09/3B CORE
BYPASS CAPACITORS
1nF CERAMIC
(MEPCO OR EQUIV.)

TOP PLANE COPPER[1] (Component Side)

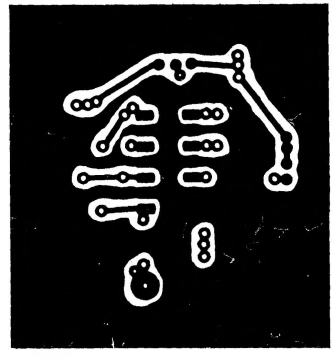


COMPONENT SIDE (Component Layout)



NOTE
(X) indicates ground connection to top plane.
* R_6 is on bottom side.

BOTTOM PLANE COPPER[1]



NOTE 1: Bond edges of top and bottom ground plane copper.

Figure 1. 28dB Non-Inverting Amp Sample P.C. Layout

ULTRA HIGH FREQUENCY OPERATIONAL AMPLIFIER SE/NE5539

NE5539 COLOR VIDEO AMPLIFIER

The NE5539 wideband operational amplifier is easily adapted for use as a color video amplifier. A typical circuit is shown in Figure 2 along with vector-scope[1] photographs showing the amplifier differential gain and phase response to a standard five step modulated staircase linearity signal (Figures 3, 4 and 5). As can be seen in Figure 4, the gain varies less than 0.5% from the bottom to the top of the staircase. The maximum differential phase shown in Figure 5 is approximately +0.1°.

The amplifier circuit was optimized for a 75Ω input and output termination impedance with a gain of approximately 10 (20dB).

NOTE
The input signal was 200mV and the output 2V. V_{CC} was ±8V.

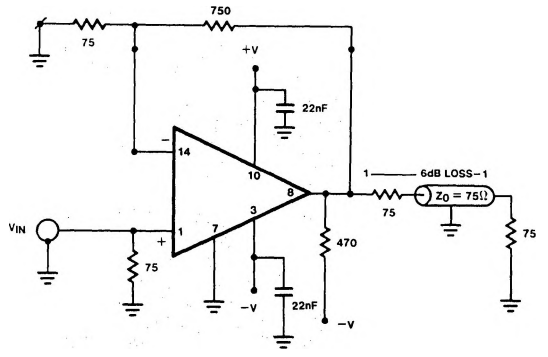


Figure 2. NE5539 Video Amplifier

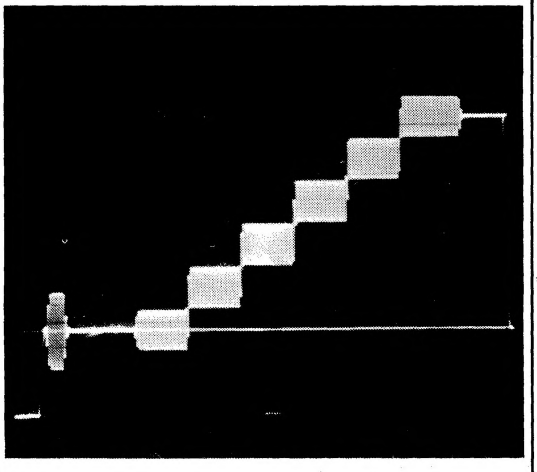


Figure 3. Input Signal

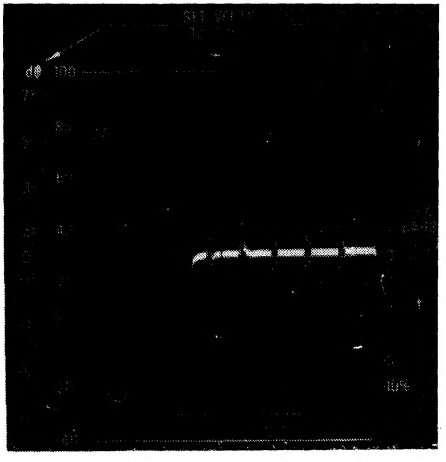


Figure 4. Differential Gain <0.5%

NOTE:
1. Instruments used for these measurements were Tektronix, 146 NTSC test signal generator, 520A NTSC vectorscope, and 1480 waveform monitor.

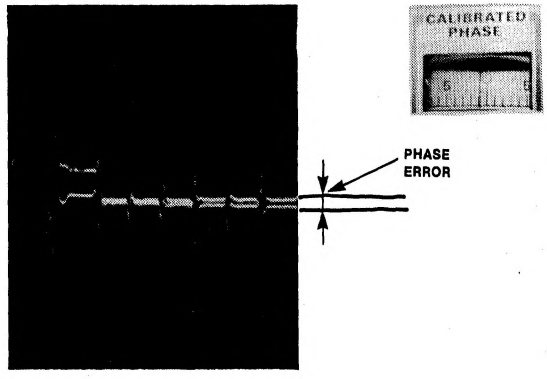
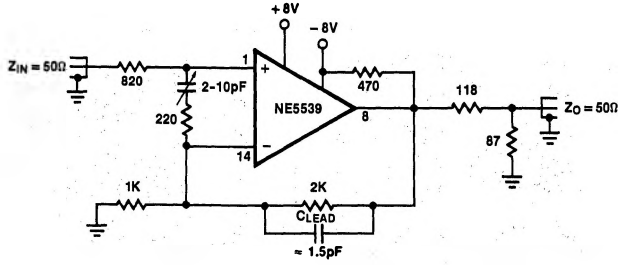


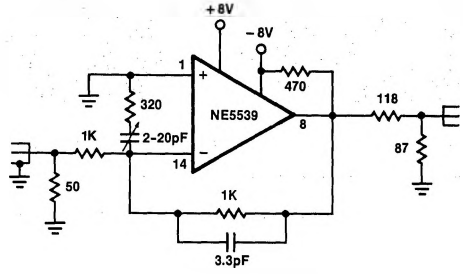
Figure 5. Differential Phase +0.1°

APPLICATIONS



[NON-INVERTING FOLLOWER]

Figure 6



[INVERTING FOLLOWER]

Figure 7

*For additional information, consult the Applications Section.